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ABSTRACT

A Seattle Central Community College project visited existing programs, surveyed need, and developed a curriculum for a future program in Laser-Electro-Optics (LEO) Technology. To establish contacts and view successful programs, project staff made visits to LEO technology programs at San Jose City College and Texas State Technical Institute, Center for Occupational Research and Development facilities (Waco, Texas), the Junior-Senior Graduate program in Electro-Optics at the University of Houston (Clear Lake City), and leading United States employers of laser technicians. A survey indicated that current prospects for LEO technician employment in Washington did not justify present establishment of an advisory committee or functioning program. A curriculum was developed as the basis of a future LEO technology program if continuing study indicates feasibility. The six-quarter program included special time and location requirements and utilized existing courses. (Proposed course content is briefly described.) (Appendixes, amounting to over one-half of the report, include a list of current two-year LEO technology programs, the San Jose City College Laser Technology curriculum, Texas State Technical Institute--Waco LEO Technology curriculum, University of Houston-Clear Lake City curriculum, and the survey form.) (YLB)

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ED190860

FINAL REPORT

Project No. 79-AHA(119)

DEVELOPMENT OF A CURRICULUM IN LASER TECHNOLOGY

Curriculum Development Project
Conducted Under
Public Law 94-482

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William J. Wasserman
Division of Science and Mathematics
Seattle Central Community College
Seattle, Washington 98122

CE 026 428

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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June 30, 1980

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I. PROJECT SUMMARY

Laser-Electro-Optics Technology programs at San Jose City College and Texas State Technical Institute were visited and evaluated. Center for Occupational Research and Development (formerly Technical Education Research Center - SW) facilities in Waco, Texas were visited. Good contacts were developed and components of existing Laser-Electro-Optics Technology programs were thoroughly examined. The Junior-Senior-Graduate program in Electro-Optics at University of Houston at Clear Lake City was visited and future student transfer opportunities were discussed. "Silicon Valley" firms, Coherent Radiation, and Spectra-Physics, Inc., leading U.S. employers of Laser Technicians, were visited, contacts established, and promises given for future assistance in Laser-Electro-Optics Technology program development.

A survey instrument indicated that current prospects for Laser-Electro-Optics Technician employment in Washington did not justify present establishment of either an advisory committee or a functioning program.

A proposed curriculum was developed to be the basis of a future program in Laser-Electro-Optics Technology if continuing study indicates feasibility.

Continuing contact with prospective Laser-Electro-Optics Technician employers should be made by either the commission, Seattle Central Community College or other community colleges. For the interim period, short courses in Laser-Electro Optics Technology should be developed by Seattle Central Community College. These should be given at appropriate locations where and when needed. Funding for a mobile equipped Laser-Electro-Optics Technology laboratory should be sought from National Science Foundation, Department of Energy and/or Department of Education.

The commission should fund a project and/or conference on High Technology to establish state needs for the immediate future.

II. VISITATIONS

In order to familiarize the author with existing Laser-Electro-Optics Technology programs and employment prospects, an organized itinerary was developed and pursued, within the available funding supplied by the grant.

Appendix 1 provides a list of currently active or prospective programs in Laser-Electro-Optics Technology. All are two year programs with the exception of University of Houston at Clear Lake City.

It was decided that the limited travel funds available could be best employed by visiting San Jose City College and Texas State Technical Institute-Waco. San Jose City College has a very successful program, on the west coast, with easy access to Coherent Radiation and Spectra Physics, the leading U.S. laser manufacturers and major employers of laser technicians. Texas State Technical Institute also has a very successful Laser-Electro-Optics Technology program and is located in the same city, Waco, Texas, as the Center for Occupational Research and Development, a prime resource for curriculum development expertise in the field of Laser-Electro-Optics Technology. Texas State Technical Institute is also relatively near the nation's major university program in Electro-Optics, University

of Houston, Clear Lake City; any articulation plans to be developed would have to include U.H.C.L.C.

A. San Jose City College

John deLeone, Director of Laser-Electro-Optics Technology at San Jose City College proved to be both very knowledgeable and helpful. The program at San Jose City College was established because the previously devised and demised program in vacuum technology had left a stock of useful equipment, the need for Laser-Electro-Optics Technicians was growing in the adjacent "Silicon Valley" home for the nation's electronics industry, and the San Jose City College electronics program had been so successful.

Following a Bay Area TV news program exposure deLeone was able to recruit large numbers of students into day and night classes beginning both fall and spring semesters. Although students begin dropping out after the first semester in the San Jose City College program, many of them obtain jobs in the nation's most active Laser Technician employment region: California's "Silicon Valley". Very few of deLeone's students finish the two year program before succumbing to the high salaried lures offered by Coherent Radiation and Spectra Physics.

Because of the employment pressure, San Jose City College has geared its program substantially toward laser manufacturing. A considerable emphasis on vacuum techniques and glassblowing was noted. Time devoted to laser tuning and troubleshooting seemed to be adequate. Study of laser applications was more limited. Because of the emphasis on manufacturing, and San Jose City College's outstanding electronics program the time and energy devoted to a study of electronics principles and techniques was extensive. Students completing the Laser Technology program could easily qualify as electronic technicians.

John deLeone offered to assist Seattle Central Community College more directly should a Laser-Electro-Optics Technology program be initiated. The San Jose City College curriculum is attached (Appendix 2).

B. Coherent Radiation, Inc. and Spectra-Physics, Inc.

Something like 95% of U.S. made lasers are produced by Coherent Radiation and Spectra-Physics. A Spectra-Physics plant was recently constructed in Oregon. Demand for laser technicians by these two companies is enormous. Existing Laser-Electro-Optics Technology programs (particularly San Jose City College) are unable to supply their voracious appetites - so they spend a great deal of time and money "raiding" each other for "new blood". As a result, starting salaries of $2000+ per month are not unusual.

The two companies' representatives were generous to the author in showing the wide range of available lasers, applications present and anticipated, and manufacturing procedures currently in use. Pete Irish, Manufacturing Manager, Coherent Radiation (3210 Porter Dr., Palo Alto, (415) 493-2111) and Susie d'Allessanro, Personnel Supervisor, Spectra-Physics (1250 W. Middlefield Road, Mountain View, (415) 961-2550) hid nothing in either tour or discussion. They made it clear that they would welcome Seattle Central Community College entering the Laser-Electro-Optics Technician training area. Definite offers of personnel to join our advisory committee, and probable assistance in obtaining equipment were typical of the type of likely service to an S.C.C.C. Laser-Electro-Optics Technology program available from both companies.

It should be noted that our "typical" students are not inclined to travel much further than Tacoma in seeking employment. Also, justification of an expensive program, by sending its recipients out-of-state would probably offend many Washington taxpayers, and certainly upset some legislators and other officials.

C. Texas State Technical Institute - Waco

Three campuses of Texas State Technical Institute offer an L-E-O Technology program, but the Waco campus is the only one of the three to present a complete program, thoroughly equipped and staffed. All three campus programs are staffed by Waco graduates, as are many other L-E-O Technology programs throughout the nation. T.S.T.I. - Waco can be regarded as the forerunner of all L-E-O Technology programs.

The T.S.T.I. program closely resembles the CORD program; a likely situation since T.S.T.I. personnel are largely responsible for the development and writing of CORD materials. T.S.T.I. Laser-Electo-Optic Technology is much more diverse than the San Jose City College program. Electronics, vacuum technology and glassblowing are taught well, but not over emphasized. Applications of laser technology - communications, measurement, holography, etc - are given their due; but lasers are built by each student, lasers are tuned, measurements are made and lasers are repaired. Students work on individual projects under close supervision. Small laboratories holding two or four students are in general use. Staff/student ratio is very high. Equipment is very new and up-to-date. The facilities are of very recent origin and were built specifically for the program. The equipment and facility construction must have cost nearly $1,000,000.

Graduates of the program (contrary to the San Jose City College model, most T.S.T.I. students do graduate) are in great demand, with some getting starting salaries in the $24,000 - 30,000 range. Very few of the graduates of the program are able to find jobs in Texas, but some return to teach at the T.S.T.I. campuses. Many find jobs at Coherent Radiation and Spectra Physics. Some even wind up at Boeing and Hanford. Strangely, there is no visible reaction in Texas to this expensive state-operated program which trains Texans (mostly) for work in other states. One has to commend the people and government of Texas for maintaining such a vital and carefully operated program for the nation.

John Simcik, Director of the Texas State Technical Institute Program, was extremely candid about problems, costs, difficulties, but was also obviously sold on the inherent worth of the endeavor. He, also, would be glad to help Seattle Central Community College establish a Laser-Electro-Optics Technology program. The T.S.T.I. curriculum is shown in Appendix 3.

D. Center for Occupational Research and Development (formerly Texas Education Research Center) - Waco

CORD is the new name for TERC-Waco. The new name was chosen to emphasize the recent separation from TERC-Cambridge. CORD personnel have done an outstanding job in developing an L-E-O Technology curriculum and modular materials to be used therein. CORD has also developed Unified Technical Concepts - Physics modules to be used in mathematics, physics, electronics instruction. UTC-Physics modules look like winners for technical physics instruction. Some are currently in use at Tacoma Community College.

CORD personnel and materials should be useful for any Laser-Electro-Optics Technology program that develops at Seattle Central Community College. Appendix 4 is a CORD (TERC) brochure giving a listing of their valuable L-E-O Technology modules.

E. University of Houston, Clear Lake City

One of the nation's most unusual universities, U.H.C.L.C., provides educational opportunities for juniors, seniors and graduate students in various High Technology disciplines, Future Studies, etc. University of Houston, Clear Lake City's program in electro-optics is outstanding. Dr. Bill Lawrence, its director, has far-ranging views in his subject area and has constructed a model program.

Opportunity for transfer of Laser-Electro-Optics Technicians to Lawrence's program appear guaranteed, due to his appreciation of the excellent job done by schools like San Jose City College and Texas State Technical Institute. He would take students in hand and personally supervise their making up any lacking prerequisites for his program. His concern for the welfare of his students shines through all of his rhetoric. I would feel confident of my students' success if I could place them in Bill Lawrence's hands.

Appendix 5 shows the U.H.C.L.C. curriculum for Laser Technicians seeking a B.S. in Electro-optics.

III. PROJECTED LASER TECHNICIAN NEED IN WASHINGTON - AN EMPLOYER SURVEY

Appendix 6 reproduces the letters used and survey document employed in an attempt to determine the possible level of Laser Technician employment in Washington for the next decade.

The discouraging result was that returns came from about 20% of the more than 500 firms contacted. Construction firms and communications utilities were almost unanimous in indicating no forseeable need for Laser Technicians. Energy companies in the Tri-cities and Boeing have hired L-E-O Technicians from San Jose City College and Texas State Technical Institute, but with the exception of a minor Boeing department no "projected needs" were returned from those sources. Many companies indicated uncertainty about 1985 and 1990. The completed results are tabulated below.

CURRENT EMPLOYMENT OF L-E-O TECHS	17
PROJECTED NEW HIRES	
1980	2
1981	4
1982	6
1985	14
1990	24

Almost two-thirds of the numbers given are attributable to one company: Mathematical Sciences Northwest. One should probably assume that the 1990 need would probably be about 50 Laser-Electro-Optics Technicians representing new hires and replacements. Since some of that number represents shifting jobs, another part can be attributed to recruits from other states and a third group may derive from self-study electronic programs and/or appropriate college or university background, the true number of available jobs in 1990 could be 15 - 20. Any responsible Washington community college instructor in 1980 would be forced to say that the number thus projected for 1990 is insufficient to justify the enormous expense of initiating such a program. Programs in food technology and various engineering technologies would be considerably more cost-effective.

Because of the discouraging results, no attempt was made to constitute an advisory committee.

IV. SUGGESTED LASER TECHNOLOGY PROGRAM FOR WASHINGTON COMMUNITY COLLEGES

A model Laser Technology program is impossible to construct, because the requirements of time and location will dictate some changes from a national model. Another concern is the attempt to utilize existing courses to teach necessary concepts. Our attempt to synthesize a curriculum taking all factors into account follows.

COURSE	LECTURE HOURS	LAB HOURS	QUARTER CREDITS
QUARTER 1			
MATH 099 (*)	5	-	5
ENGLISH 105 (*)	3	-	3
PHYSICS 112 (*)	3	2	4
LASER TECH "L"	2	8	5
	13	10	17
QUARTER 2			
MATH 101(*)	5	-	5
ENGLISH 106 (*)	3	-	3
PHYSICS 113 (*)	3	2	4
LASER TECH "M"	2	8	5
	13	10	17
QUARTER 3			
MATH 105 (*)	5	-	5
ENGLISH 108 (*)	3	-	3
ELECTRONICS "E"	2	4	4
LASER TECH "N"	2	8	5
	12	12	17
QUARTER 4			
GLASSBLOWING "G"	-	6	3
SCIENTIFIC COMPUTER PROG."C"	2	6	5
ELECTRONICS "F"	2	4	4
LASER TECH "O"	2	8	5
	6	24	17

* From Catalog, Seattle Central Community College

COURSE	LECTURE HRS.	LAB HRS.	QTR. CREDITS
QUARTER 5			
VACUUM TECHNIQUES "V"	1	4	3
MACHINE SHOP "S"	-	6	3
LASER APPLICATIONS "A"	2	3	3
LASER TECH "P"	2	8	5
SOCIAL SCIENCE ELECTIVE	3	-	3
	8	21	17
QUARTER 6			
INDUSTRIAL SAFETY PRACTICES "I"	2	-	2
HOLOGRAPHY "H"	1	3	2
LASER APPLICATIONS "B"	2	3	3
LASER PROJECT "Z"	-	10	5
LASER TECH "Q"	2	8	5
	7	24	17

MATH 099, 101 and 105 should include plane and solid geometry formula review, radian measure, angular motion, three-dimensional coordinate systems, plane polar coordinates, graphs of trig functions, inverse trig functions, exponential functions, semilog and log-log graphical plots, vector addition, vector components, unit vectors, vector and scalar products, experimental error, significant figures, probable error and standard deviation. If subjects are omitted from the courses specified, they should be covered by one or more "Math Lab Modules"

PHYSICS 112 and 113 should cover SI units, dinensional analysis, fundamental and derived quantities, measuring instruments, significant figures, vectors, scales, statics, kinematics, harmonic motion, laws of motion, work, energy, power and thermal expansion, gas laws, heat exchange, specific heat, phases of matter, wave motion (fronts, phases, amplititude, wavelength, speed, reflection, standing, sound, interference). The physics courses should also include charge, electric field, potential, current, resistance, Ohm's Law, Power Law, Kirckhoff's equations, series and parallel circuits, resistor color code, potentiometers, rheostats, voltage dividers, equivalent circuit rules, batteries, electrical symbolsand schematics, measuring D.C. voltage, current and resistance, energy conversion to electricity, ohmeters, multimeters, switches, voltmeters, anmeters, transducers (thermistors, platinum resistance thermometers, strain gauges), magnetism, induction, D.C. motors. Alternating current should also be included - electromagnetism, AC motors, sine waves and properties, capacitance, delectric strength, impedance, phase angles, voltage vectors, inductance, Lenz's Law, Faraday's Law, AC generators, and 3-phase circuits. Wave optics topics should include light sources, units, absorption, scattering, interference, diffraction and polarization. If these topics are not included in Physics 112-113, the omitted subjects should be included in modules incorporated into Laser Tech or Electronic classes or given as a separate 1-2 credit modular self-paced Physics course.

ELECTRONICS "E" & "F"should include use of tools, safety, soldering and desoldering,circuit component layout, circuit board fabrication, color codes for resistors and other components, wire sizes, RC circuits, types of capacitors, capacitive reactance, capacitors in series and parallel, time constants, RI circuits, inductive reactance, transformers, RLC series and parallel circuits, calibration of meters,use of shunts, potentiometer circuits, Wheatstone bridges, AC bridges, function generators, VTVM. potentiometers, thermocouples, wattmeters, oscilloscopes, semiconductors, p-n junction, diode action, vacuum diodes, rectification, voltage multipliers, filters (RC,LC)

voltage regulators, junction transistors, hybrid transistors, load-line analysis, transistor characteristic curves, silicon rectifier, unijunction transistors, field effect transistors, vacuum tube characteristics, multi-stage transistor amplifier circuits, cascade amplifiers, decoupling, frequency response, transformer coupling, push-pull amplifiers, DC amplifiers, chopper amplifiers, phase inversions, feedback, tunnel diodes, relaxation oscillators, operational amplifiers.

LASER TECH "L" should include laser elements, He-Ne gas laser operation, laser physics, optical cavities, laser light properties, laser system survey, laser safety.

LASER TECH "M" should include reflection, refraction of light, graphical ray tracing techniques, f-stops and apertures, imaging with a single lens, types of lenses, focal points, imaging with multiple lenses, optical tables and benches, filters, optical windows, beam splitters, mirrors, lenses, polarizers, gratings.

LASER TECH "N" should include laser power and energy measurements, flashlamps, discharge circuits, pulse-forming networks for optically pumped solid lasers, CW arc lamps & power supplies for CW lasers, safe operation and measurements with argon, CO_2, ruby, Nd-YAG, dye and semiconductor lasers, ruby laser Q switching, types and properties of optical materials, cleaning optical components.

LASER TECH "O"should include photo detectors, calorimeters, laser power meters, laser modulation, Q switching devices including electro-optic, rotating prism, acousto-optic and bleachable dye methods; laser collimators, autocollimators, spatial filters, beam expanders, wavelengrh, dispersion and refractive index with prism/grating spectrometers.

LASER TECH "P" should include monochrometers, spectrophotometers, longitudinal modes in laser output, use of Michelson and Twyman-Green interferometers for optical testing, use of Mach-Zehnder interferometer for measurement of gas refractive index, concept and measurement of modulation transfer function, digital measurement, bias conditions of npn and pnp transistor switches, relays as switching elements, gating circuits, coincidence and anticoincidence circuits.

LASER TECH "Q" should include digital IC's, diode logic, resistor-transistor logic,diode-transistor logic, direct-coupled transistor logic, transistor-transistor logic, emitter coupled logic, flip-flops, multivibrators, trigger circuits, numbering systems, binary conversion codes (BCD, octal, digital logic), Boolean algebra, NOR and NAND gates, adder and half-adder configurations, digital symbols, counters, converters (A/D, D/A), ladder resistor networks, digital readout devices, digital instruments (DVM, frequency, synthesizer, phase frequency detector)

LASER APPLICATIONS "A" and "B" ahould include cutting, drilling, welding, air pollution monitoring with lasers, data processing, data display, optical memories, holographic non-destructive testing, medical applications, ranging, angle tracking, optical communication systems, laser spectroscopy, laser isotope separation, laser fusion.

LASER PROJECTS "Z" should be the construction and testing of a laser (optical, HeNe, CW-pumped, Nd:YAG, CO_2) or the use of an available laser for a significant application.

INDUSTRIAL SAFETY PRACTICES "I" should include general lab safety procedures, chemical and electrical hazards and controls, safe wiring, toxic fumes, noise hazards, personnel protection.

VACUUM TECHNIQUES "V" should include vacuum systems, thermocouple and ion gauges, gauge controllers, vacuum valves, cold traps, mechanical and oil diffusion pumps, evacuation and filling of vessels, vacuum deposition of thin films.

MACHINE SHOP "S" should include lathe, milling machine, drill press, grinder, sheet metal cutter and bender, hole punch, band saw operation, preparation of shop drawings, dimensional tolerances, material of fabrication familiarization, mechanical and chemical finishes.

V. RECOMMENDATIONS TO COMMISSION

A. Authorize and divert funds to Seattle Central Community College for employment of a laser-Electro-Optics instructor and purchase of minimal lasers, measuring equipment and supplies to

1. teach a basic Laser Technology course where needed at Puget Sound community colleges.
2. teach short courses (1-2 weeks) at other community colleges in Washington State.
3. develop additional short courses in L-E-O Technology to be given at appropriate locations where and when needed.
4. continue contact with potential Laser-Electro-Optics Technician employers to determine extent of need for such technicians.

B. Authorize and fund a project and/or conference on High Technology to establish both short and long range needs for state support of individual programs.

C. Apply to National Science Foundation, Department of Energy, Department of Education for purchase, equipment and maintenance of a mobile equipped L-E-O Technology laboratory to be used in conjunction with A.

APPENDIX 1

Current 2 Year Programs in Laser-Electro-Optics Technology

Albuquerque Technical Vocational Institute
525 Buena Vista NE
Albuquerque, NM 87106
(505) 843-7250
Walter Rice

Camden County College
P. O. Box 200
Little Gloucester Road
Camden, NJ 08012
(609) 227-7200
Fred Seeber

Cincinnati Technical College
3520 Central Parkway
Cincinnati, OH 45223
(513) 559-1520
Prem Katra

Essex County Technical Career Center
91 W. Market St.
Newark, NJ 07103
(201) 622-1100
Anthony Napolitano

Idaho State University
Pocatello, ID 83209
(208)236-3516
Richard Davis

New Mexico Highland University
Las Vegas, NM 87701
(505) 425-7511
Fred Yarger

North Central Technical Institute
1000 Schofield Ave.
Wausau, WI 54401
(715) 675-3331
Jim Johnson

Northern NM Community College
3540 Orange St.
Los Alamos, NM 87544
(505) 753-7141
Dr. Sigfredo Maestas

Pasadena City College
1570 E. Colorado
Pasadena, CA 91106
(213) 578-7133 or 578-7135
Keith Miller

San Jose City College
2100 Moorpark Ave.
San Jose, CA 95128
(408) 298-2181
John deLeone

Springfield Technical CC
1 Armory Square
Springfield, MA 01005
(413) 781-6470 or 7817822
Dan Courtney

Texas State Technical Institute
Amarillo Campus
Amarillo, TX
(806) 335-2316
Clyde Lowery

TSTI
Harlingen Campus
P. O. Box 2628
Halingen, TX 78550
(512) 425-4922
Carl Lansford

TSTI
Waco Campus
Waco, TX 76705
(817) 799-3611
John Simcik

Union County Tech Inst
1776 Raritan Road
Scotch Plains, NJ 07076
(201) 889-2000
Jack Lowenthal

Vincinnes University
1002 N. 2nd St.
Vincennes, IN 47591
(812) 882-3350 or 885-4505
Herbert Deigl or Mike Meyers

College of DuPage
Glen Ellyn, IL 60137
(312) 858-2800
W.R. Johnson, Assoc Dean of Tech (Program pending)

Moorpark College
7975 Campus Road
Moorpark, CA 93021
(805) 529-2321
Dr. Clint Harper (Program pending)

University of Houston (Clear Lake City)
Houston, TX
(713) 488-9286
Bill Lawrence (Junior, Senior, Graduate only)

APPENDIX 2

San Jose City College
Laser Technology Curriculum

San Jose City College Laser Technology Curriculum

COURSE TITLE	CREDITS
SEMESTER NO. 1	
Laser 100 - Intro. to Laser Technology	3
Laser 105A - Laser Electronics	4
Electronics 120A - Electronics Math	2
Photography 22 - Elementary Photography	3
Machine Technology 101 - Intro. to Machine Tech	3
	15
SEMESTER NO. 2	
Physics 2A - General Physics	4
Laser 101 - Laser Optics	4
Laser 105B - Laser Electronics	4
Electronics 120B - Electronics Math	4
	16
SEMESTER NO. 3	
History 17A or Hist. 55	3
Speech 10,20,21,40,41,55,59, or 45	3
Laser 102 - Laser Technology	4
Laser 111 - Laser Measurements	3
Ethnic Studies	3
	16
SEMESTER NO. 4	
Phys. Ed. - activity	1
History 17B or Govt. 55	3
English 1A,92,91A-B,or E.S.L. 1	3
Laser 112 - Vacuum techniques	4
Humanities Elective	2
	13

APPENDIX 3

Texas State Technical Institute - Waco
Laser-Electro-Optics Technology Curriculum

LASER-ELECTRO-OPTICS TECHNOLOGY CURRICULUM, Texas State Technical Institute - Waco

COURSE TITLE	LECTURE HOURS	LAB HOURS	CREDITS
FIRST QUARTER			
Seminar in Laser Electro-Optics	1	0	1
Fundamentals of Lasers and Laser Safety	3	3	4
Laser-Electro-Optics Calculations	0	3	1
Circuit Analysis I and Electrical Safety	3	3	4
Applied Algebra	3	2	4
Physical Measurements Skills	3	3	4
	13	14	18
SECOND QUARTER			
Laser-Electro-Optics Components	3	3	4
Circuit Analysis II	3	4	4
Magnetics	3	3	4
Technical Trigonometry	3	2	4
Technical Physics	3	3	4
	15	15	20
THIRD QUARTER			
Geometric Optics	3	4	5
Measurements and Calibrations	3	3	4
Shop Skills	0	3	1
Electronics I	3	3	4
Introduction to Technical Communications	2	2	3
	11	15	17
FOURTH QUARTER			
Continuous Wave Lasers	3	6	5
Electro-Optics Measurements L	1	3	2
Electronics II	3	3	4
Approved Elective			4
			15

	LECTURE HOURS	LAB HOURS	CREDITS
FIFTH QUARTER			
Pulsed Lasers	3	6	5
Wave Optics	3	4	5
Electronics III	2	3	3
Special Topics in Algebra and Trigonometry	3	2	4
	11	15	17
SIXTH QUARTER			
Electro-Optics Devices	3	6	5
Electro-Optics Measurements II	2	4	5
Digital I	3	4	4
Approved Elective			3
			17
SEVENTH QUARTER			
Laser Electro-Optics Applications	3	4	5
Laser Electro-Optics Project	0	12	4
Technical Report Writing I	2	2	3
Approved Elective			3
			15

APPENDIX 4

CORD (TERC)
Laser-Electro-Optics Technician Brochure

BEST COPY AVAILABLE

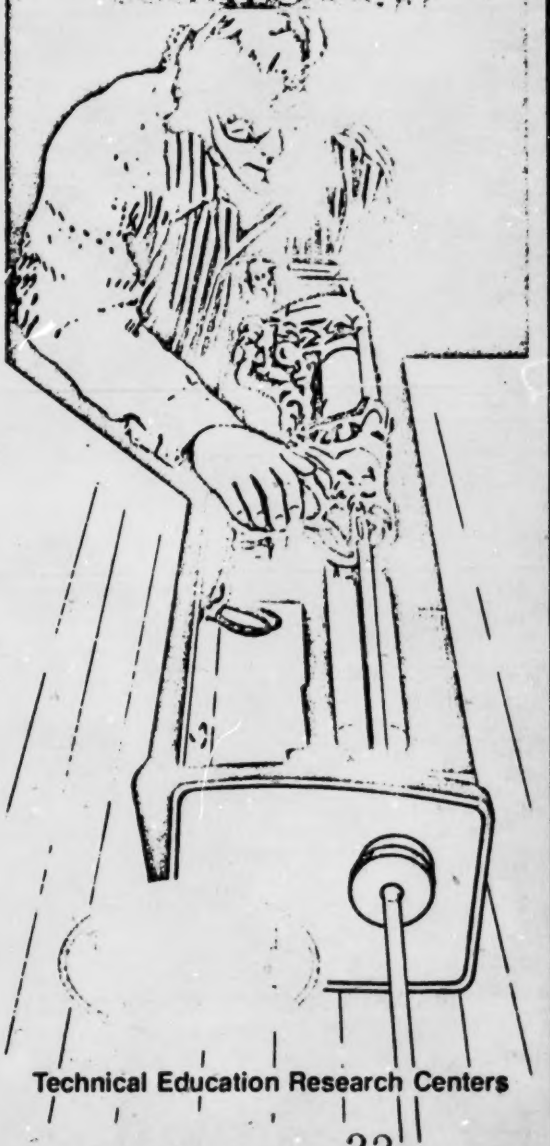
Technical Education Research Centers (TERC) is a private, non-profit organization dedicated to research, development and dissemination of technical educational programs in the United States. The materials described in this brochure, as well as the following list of materials related to the Laser/Electro-Optics Technology are available from TERC at the address below.

1. Curriculum Guide.
2. Tips for Teachers of Course I.
3. LEOT Educational Equipment and Supplies.
4. Career Opportunities in Lasers.

Technical Education Research Centers

P.O. BOX 4395 • 103 Airline Drive • Waco, Texas 76705

laser electro-optics technology



Technical Education Research Centers

The laser is no longer a scientific curiosity looking for an application. Lasers are being used in industry with applications in automatic supermarket check-outs, communications, surveying, construction alignment, welding, and product testing. It is a tool so delicate it can pierce a diamond; and so precise that a millionth of an inch can be measured with ease.

Laser/Electro-Optics Technology is rapidly developing with essentially unlimited potential for the trained technician. This field is challenging at many levels of technical expertise and provides jobs with great personal satisfaction and potential for rapid advancement.

Laser/Electro-Optics (LEO) technicians are needed to develop, assemble, operate, test and maintain lasers and other optical devices for use in industry.

An educational program for LEO technicians has been developed under the sponsorship of the United States Office of Education. The curriculum is designed to be used by two-year, post secondary schools to prepare students for entry level employment or advance training of technicians who are already employed in the related fields. The instructional materials are also being used by employees for "in-house" training and by individuals for self-study.

The LEOT Program is a complete and comprehensive educational plan for learning LEO Technology. The program was written by people actively employed in various aspects of the LEO industry. The curriculum was guided by an Industrial Advisory Committee consisting of representatives that actually hire LEO technicians. To insure the program is educationally sound, the program was designed by educational specialists. Each of the one hundred instructional modules contains measurable performance based objectives with "hands-on" laboratory experiments. The materials have been used successfully in the following ways:

1. Two-year programs for preparing new LEO technicians.
2. Supplements to existing programs in physics, electronics, glassworking, vacuum systems, etc.
3. Short courses for presenting specific information to existing employees.
4. Industrial "in-house" instruction.

Because of the modular approach, the program is flexible enough to be adapted to local employment needs.

This is a proven program which has been evaluated in a model two-year program at Texas State Technical Institute. Over 75 graduates during the past four years have used the materials and are now successfully employed in the LEO industry.

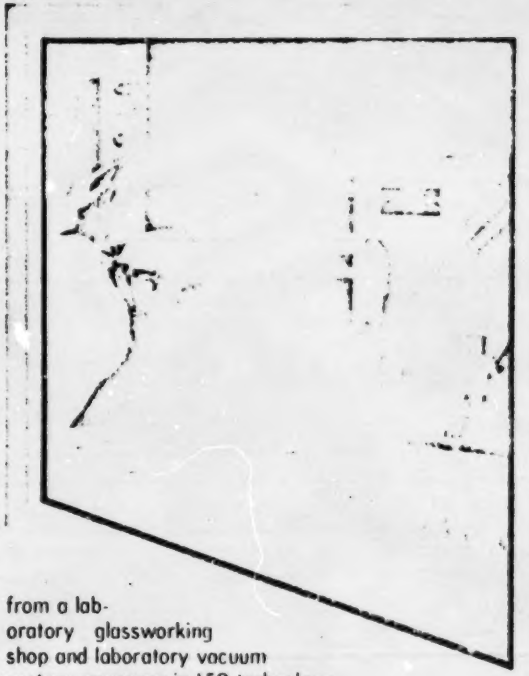
BEST COPY AVAILABLE

COURSE I – INTRODUCTION TO LASERS (Eleven modules) – to introduce the new student to the principles of a laser, its output characteristics and safe operating practices.

COURSE II – GEOMETRIC OPTICS (Eleven modules) – to give the student the mathematical ability and graphical techniques necessary to analyze a ray of light as it passes through an optical component system.

COURSE III – LASER TECHNOLOGY (Eleven modules) – to explore in depth six specialized groupings of lasers.

COURSE IV – EXPERIMENTAL OPTICAL METHODS (Nine modules) – to develop the skills and knowledge necessary to produce usable items



from a laboratory glassworking shop and laboratory vacuum system necessary in LEO technology.

COURSE V – LIGHT SOURCES AND WAVE OPTICS (Eleven modules) – to give a thorough understanding of the characteristics of light sources and the wave nature of light and holography.

COURSE VI – LASER AND ELECTRO-OPTIC COMPONENTS (Eleven modules) – to give the student the practical understanding of optical components and accessories ordinarily derived only from years of experience in the laboratory.

COURSE VII – LASER ELECTRO-OPTIC DEVICES (Ten modules) – to explain the theory and operation of special purpose devices to measure laser output parameters, modulate and Q-switch lasers; also includes special techniques in photography and holography.

COURSE VIII – LASER APPLICATION (Ten modules) – a study of the current application of lasers in material processing, data processing, testing and monitoring, ranging and alignment, communication, and medicine.

COURSE IX – LASER PROJECTS (Seven modules) – the student will build and operate a laser or electro optical device to acquire actual job experience in building, operating, and testing a LEO system.

COURSE X – LASER/ELECTRO-OPTIC MEASUREMENTS (Eight modules) – to study spectrometers, interferometers and associated measurement techniques which are important in LEO technology.

APPENDIX 5

UNIVERSITY OF HOUSTON

CLEAR LAKE CITY

B.S. Curriculum for students
entering with 54 hours of
background coursework

University of Houston, Clear Lake City

MATHEMATICS

MATH 3332	Calculus Applications
MATH 3333	Linear Systems Applications

OPTICS

EOPT 3130	Elementary Physics
EOPT 3131	Introduction to Electro-Optics
EOPT 3132	Geometric Optics
EOPT 3333	Projects
EOPT 3431	Introduction to Lasers and Masers
EOPT 4132	Wave Optocs
EOPT 4332	Technology of Photon Detectors
EOPT 4431	Laser Applications
EOPT 4432	Laser System Components
EOPT 4434	Seminar
EOPT 4531	Electro-optical Instrumental Analysis
EOPT 4532	Electro-optical Measurement Systems

COMPUTER SCIENCE

CSCI 3131	Time Sharing Language Skills
CSCI 3132	BASIC/FORTRAN

ELECTRONICS

COMPUTER HARDWARE

CTEC 3130	Applications of MSI and LSI
CTEC 3131	Medium and Large Scale Digital Integrated Circuits
CTEC 3132	Logic Analysis with Boolean Algebra

PROCESS CONTROL TECHNOLOGY

PROC 3114	Prototype Fabrication
PROC 3130	Applicaticns of Linear Integrated Circuits
PROC 3132	Linear Integrated Circuits
PROC 3133	Electronic Components and Devices

APPENDIX 6

Survey of Washington
employers regarding
Laser Technician
employment needs
in the 1980's

SEATTLE CENTRAL COMMUNITY COLLEGE
1701 Broadway Seattle, Washington 98122

TO: Presidents, Executive Vice-Presidents, Production Managers, Laboratory Directors, Technology-Based Industries and Institutions of Washington State

FROM: William J. Wasserman, Laser Technology Curriculum Development, Science and Mathematics Division

RE: PROPOSED LASER TECHNOLOGY PROGRAM FOR S.C.C.C.

Seattle Central Community College is exploring the possibility of establishing a program for the training of laser technologists. Several colleges, notably San Jose City College and Texas State Technical Institute, have excellent curricula primarily oriented toward training of persons engaged in laser manufacturing. The proposed S.C.C.C. program would be more concerned with laser utilization and repair.

In order to establish that a need for such a program exists in our state, and to facilitate our program development, we are sending you the enclosed questionnaire. We would appreciate any input that your institution can provide for our guidance. If more copies of the questionnaire are needed, please copy or request more by phone or mail.

Your needs in the field laser technology will be of primary importance in the development of any curriculum which emerges from this study.

Thank you for your help.

WJW:Km
Enclosure

SEATTLE CENTRAL COMMUNITY COLLEGE
1701 Broadway, Seattle, Washington 98122

April 28, 1980

TO: Personnel Managers
Technology-Based Industries and Institutions of Washington State

FROM: William J. Wasserman, Laser Technology Curriculum Development,
Science and Mathematics Division

RE: PROPOSED LASER TECHNOLOGY PROGRAM FOR S.C.C.C.

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Thank you for your help.

WJW:mlp
Enclosure

SEATTLE CENTRAL COMMUNITY COLLEGE

LASER TECHNOLOGY SURVEY

CURRENT AND PROJECTED LASER TECHNICIAN EMPLOYMENT

	1980	1981	1982	1985	1990	Currently Employed (total)
Total Projected Need	___	___	___	___	___	_____
Manufacturing	___	___	___	___	___	_____
Repair	___	___	___	___	___	_____
Communications	___	___	___	___	___	_____
Medical	___	___	___	___	___	_____
Testing	___	___	___	___	___	_____
Other	___	___	___	___	___	_____

CURRICULUM CONTENT

We would like to have a laser technician curriculum include:

	YES	NO	UNCERTAIN
Laser Physics	___	___	___
Glass Fabrication	___	___	___
Vacuum Technology	___	___	___
Photographic Techniques	___	___	___
Materials Processing	___	___	___
Data Processing	___	___	___
Ranging	___	___	___
Testing-Environmental	___	___	___
Testing-Non Destructive	___	___	___
Communications	___	___	___
Medical Applications	___	___	___
Interferometry	___	___	___
Safety Practices	___	___	___
Drafting	___	___	___
Machine Shop Practice	___	___	___
Other _____	___	___	___
_____	___	___	___
_____	___	___	___

CONTINUING EDUCATION

We would encourage our current and future laser technicians to update their training by taking courses in:

COURSE	YES	NO	UNCERTAIN
Physics-Electricity and Magnetism	___	___	___
Physics-Optics	___	___	___
Electronics-General	___	___	___
Electronics-Assembly	___	___	___
Electronics-Testing	___	___	___
Communications Skills	___	___	___
Mathematics	___	___	___
Geometrical Optics	___	___	___
Wave Optics	___	___	___
Introduction to Lasers	___	___	___
Drafting	___	___	___
Machine Shop	___	___	___
Glass Blowing	___	___	___
Laser-Electro-Optics Components	___	___	___
Electronic Instruments and Calibration	___	___	___
Semi-Conductor and Vacuum Tube Fundamentals	___	___	___
Communications	___	___	___
Laser-Electro-Optic Devices	___	___	___
Laser-Electro-Optic Measurement	___	___	___
Photography and Holography	___	___	___
Medical Applications of Lasers	___	___	___
Other_____	___	___	___
_____	___	___	___
_____	___	___	___

COMPANY _____

ADDRESS _____

_____(city, zip)

PERSON ANSWERING QUESTIONNAIRE _____

TITLE_____ PHONE NUMBER_____

I, or an associate, would/would not (cross out one) like to serve on an S.C.C.C. Advisory Committee for Laser Technology if it becomes a part of the curriculum.